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YALE University has acquired by purchase another entire city block in the center of New Haven.

THE enrollment in the College of Medicine of the University of Cincinnati shows an increase of about 40 per cent. over last year. The enrollment in 1916 was 102 compared with 143 for the year 1917-18.

IN the Oregon Agricultural College Adolph Zeifle has been made dean of the newly created school of pharmacy; Miss Ava B. Milam dean of the school of home economics, and E. K. Soper, head of the department of mines at the University of Idaho, has been appointed dean of the school of mines to fill the vacancy made by the resignation of Dean H. M. Parks to head the Oregon Bureau of Mines and Geology.

PROFESSOR HOTCHKISS, of the department of business education of the University of Minnesota, has been made chief of the department of economics during the absence of Professor Durand.

PROFESSOR C. C. PALMER, of the College of Agriculture of the State University of Minnesota, has been appointed head of the department of bacteriology, physiology and hygiene, at the Delaware College, Newark, Del.

DR. ALBERT C. HERRE, for several years past professor of geography and agriculture in the Bellingham, Washington, State Normal School, has recently been appointed head of the department of biology in the same institution.

EBEN H. TOOLE, recently of the Kansas Agricultural College, Manhattan, Kansas, has been appointed to succeed Professor G. N. Hoffer as assistant professor of plant pathology and physiology, at Purdue University. Professor Hoffer has been transferred to the Agricultural Experiment Station of Purdue.

DR. C. C. FORSAITH, instructor in botany in Dartmouth College, has been appointed instructor in wood technology in the New York State College of Forestry.

E. A. REID, for the past two years instructor in electrical engineering at Minnesota, has

resigned to accept a similar position at the University of Illinois.

PROFESSOR CLARENCE A. MORROW, formerly professor of chemistry in the Nebraska Wesleyan University, has been elected assistant professor of agricultural biochemistry in the University of Minnesota.

MRS. J. A. NYSWANDER has been appointed assistant professor of mathematics at the University of Nevada, to take the place of her husband, who has been called to government service.

DISCUSSION AND CORRESPONDENCE

THE "AGE AND AREA" HYPOTHESIS OF WILLIS

THE "Age and Area" hypothesis of Willis, recently discussed and endorsed by Professor De Vries in *SCIENCE*,¹ states that "the area occupied by any given species (of plants) at any given time in any given country in which there occur no well-marked barriers depends upon the age of that species in that country." The older the species is, in other words, the wider is its range. If confirmed, this hypothesis would be of the greatest scientific importance, for not only would it discredit the efficacy of natural selection—the point chiefly emphasized by its author and Professor De Vries—but, by enabling us to identify with certainty the most widespread types as the most ancient ones, in any given region or in the world as a whole, it would also clear up a host of vexed questions in plant geography and plant phylogeny. Certain objections to the hypothesis appear to be so great, however, as to cast doubt upon its universal applicability; and a careful study of the floras of Ceylon and New Zealand, the regions with which Professor Willis has chiefly worked, serves to emphasize the complexity of the whole problem involved.

Factors other than age evidently share in determining the area occupied by a species.

¹ De Vries, H., "The distribution of endemic species in New Zealand," *SCIENCE*, N. S., Vol. XLV., No. 1173, pp. 641-642, June 22, 1917.

Barriers of various sorts certainly do exist almost everywhere and effectively limit the extent to which a species may be dispersed. We have reason to believe that many types are as widespread as they can ever be and that no increase in age, other factors remaining constant, will widen their ranges. In fact, evidence from fossils shows that certain species and genera occupy to-day smaller areas than they formerly did.

Factors inherent in the plant itself are also bound to influence the extent of its distribution. Types which are hardy and able to thrive under a wide range of conditions will obviously spread farther and faster than those which are sensitive or specialized. The growth habit of a plant, too, seems to be very important in determining distribution, trees usually occupying small ranges, shrubs wider ones and herbs the widest of all. This may be observed in almost any flora and is very noticeable in those of Ceylon and New Zealand, where the endemic species, necessarily of limited dispersal, are predominantly trees and shrubs; the non-endemic, widespread ones, predominantly herbs. The data as to relative commonness of species in Ceylon given in Trimen's "Flora," the authority used by Professor Willis, also show clearly that the herbs are much commoner and more widely dispersed than are the woody plants.

The theory that the most widespread types are the oldest meets with further difficulties from some of its implications. The fact which we have just mentioned, that species of herbs tend universally to have much wider ranges than those of shrubs or trees, a circumstance long ago noted and emphasized by De Candolle, must mean, if we follow Professor Willis, that the herbaceous element in the angiospermous vegetation of the globe is more ancient than the woody element. Against this conclusion there are serious objections, and it is at present maintained by few botanists or geologists. In its interpretation of endemic types the hypothesis is also open to objection, since it regards endemic species and genera in all cases as of recent origin, the newest element in their respective

floras. There is much evidence, however, from taxonomy and paleobotany, that in many cases endemics are relicts of types once much more widely spread which have disappeared from all regions save one. Such endemics are evidently ancient rather than recently acquired members of a flora.

This point involves the necessary corollary to his hypothesis which Professor Willis brings forward when he states² that the "dying out" of a species is a rather rare event, usually requiring some profound geological or climatic change. This belief in the essential permanency of types necessarily leads Professor Willis to the view that species or genera which are isolated taxonomically and without near relatives have become so not through the extinction of intermediate and connecting forms, but by a single step, a view demanding belief in the frequency and permanence of wide mutations. If we look again at the fossil record, however, we see such an overwhelming array of extinct types that it is hard to attribute their extermination in every case to a cataclysmic disturbance. This difficulty increases when we examine the flora of any such isolated region as Ceylon or New Zealand. If Professor Willis's hypothesis is correct, the original invaders of each of these islands—its oldest plant inhabitants—should now be the most widespread and common members of its flora, in contrast to the endemic forms which have sprung from them and are thus more rare and local. If we look at the flora of Ceylon, however, we find that there are no less than 63 genera of dicotyledons alone, 8 per cent. of the whole, which, though not endemic in Ceylon, are represented only by *endemic* species. In New Zealand 90 non-endemic genera of dicotyledons, or 43 per cent. of the whole, are similarly represented only by endemic species. In these cases, where in each genus is the parent species or group of species, the original invader, which has supposedly given rise to all these endemic forms and which should now be more common than any of them? It certainly

² Willis, J. C., "The evolution of species in Ceylon, with reference to the dying out of species," *Annals of Botany*, Vol. XXX., 1916, p. 1.

has died out in some way, since it no longer exists in the island.

A further objection to the hypothesis lies in its particular application to the flora of New Zealand. On the basis of the soundings, Professor Willis believes that the land bridge over which came the original plant population of the islands entered at about the center of the chain. He presumably refers to the strip of shoal water running northwesterly from New Zealand toward Australia, on which stands Lord Howe Island. On the assumption that all the original invaders entered at this central point and spread north and south, and that in doing so they followed the rule of "age and area," Professor Willis makes and verifies a series of predictions as to the disposition of the flora to-day. His whole argument hinges on the existence of an original central point of entry and dispersal. It neglects entirely the evidence that a large and characteristic element of the New Zealand flora entered the islands *not* from Australasia on the west, but from the antarctic regions to the south. Hooker, Wallace and Cheeseman, the foremost authorities on antarctic floras, state their belief that, even if there was never a complete land bridge from the southern extremity of New Zealand to the antarctic continent, there was at least a considerable southward extension of New Zealand at one time (for which there is also evidence on the ocean bottom) over which the "antarctic types" came north and entered it. If the southern tip of New Zealand was thus also a center of entrance and dispersal for a large floral element, Professor Willis's observations are far from supporting his hypothesis. He notes particularly the scarcity of endemic species at both the north and south extremities of the islands, and points to this fact as convincing confirmation of his views, since (assuming a single central point of dispersal) the extremities would be populated last and would have produced as yet but few endemics. But assuming a second point of entry, at the southern extremity of the islands, we should expect to find there to-day, if the "age and area" hypothesis is true, a decided bunching of endemic species. Either the

hypothesis is incorrect, or the commonly accepted theory as to the dispersal of the antarctic floras is erroneous.

Against Professor Willis's hypothesis are therefore to be urged (1) that it disregards important factors other than age which determine area of dispersal; (2) that the conclusions which it necessarily implies as to the antiquity of certain plant types are opposed by a preponderance of evidence; (3) that, contrary to its expressed assumption, many species are becoming rarer and are "dying out"; and (4) that it fails to explain the distribution of the New Zealand flora.

There are doubtless a large number of species which are still extending their ranges and for which Professor Willis's hypothesis holds good. Many persons will also sympathize with his chief contention, that natural selection can not fully explain the origin of endemic species and genera; and a few will share his belief in the frequency and importance of very wide mutations. The problems involved in the origin, dispersal and extinction of species, however, are evidently far too complex to be covered by any single inclusive hypothesis like that of "age and area."

E. W. SINNOTT

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ERASMUS DARWIN AND BENJAMIN FRANKLIN

TO THE EDITOR OF SCIENCE: Referring to the Notes on Erasmus Darwin and Benjamin Franklin in SCIENCE of September 21, last, on page 291 near the bottom of Column 1 is the remark that

Even as far back as 1772 some one was puzzling over the idea of making a phonograph.

He quotes Dr. Darwin as saying:

I have heard of somebody that attempted to make a speaking machine, pray was there any truth in such reports?

The "speaking machine" referred to was not a phonograph for reproducing speech, but a machine which could talk of itself. There was an effort to make such a machine, which the writer of the article quoted seems not to have heard of. This effort was continued